

REMARKS

The Examiner is thanked for the thorough examination of the application. It is believed that no new matter is added to the application by this Amendment.

Status Of The Claims

Claims 1, 2 and 4-10 are pending in the application. Support for the amendments to claim 1 can be found in paragraph 0010 of the specification. Support for claim 4 can be found in paragraph 0041 of the specification. Support for claim 5 can be found in paragraph 0042 of the specification. Support for claim 6 can be found in paragraph 0043 of the specification. Support for claim 7 can be found in paragraph 0044 of the specification. Support for claim 8 can be found in paragraph 0052 of the specification. Support for claim 9 can be found in paragraph 0055 of the specification. Claim 10 corresponds to claims 1, 2 and 5.

Rejections Based On Nakamura

Claim 1 is rejected under 35 U.S.C. §102(b) as being anticipated by Nakamura (EP 0 999 640 A2). Claim 2 is rejected under 35 U.S.C. §103(a) as being unpatentable over Nakamura in view of Bolt (U.S. Patent No. 4,857,246). Applicants traverse.

The present invention pertains to a novel method to manufacture a single crystalline aluminum nitride film that has low dislocation density, has little lattice mismatch and has excellent crystallinity. Of the many embodiments of the present invention, claim 1 typically sets forth a novel process that includes nitriding a single crystalline α -Al₂O₃ substrate to form a single

crystalline aluminum oxynitride layer and an aluminum nitride film as an outermost layer directly on the single crystalline aluminum oxynitride layer.

Distinctions of the invention over Nakamura and Bolt have been placed before the Examiner in the Amendments filed February 26, 2006 and September 6, 2005. For brevity, these traversals are not repeated here but are incorporated by reference.

Nakamura fails to disclose a method for forming a single crystalline aluminum nitride film that does not entail using MOCVD. Nakamura additionally fails to disclose a method where the aluminum nitride film is formed directly on the aluminum oxynitride layer. Nakamura further fails to disclose crystalline aluminum oxynitride.

However, Nakamura has the following discussions in paragraphs **0021** and **0036**:

“By performing such an initial nitriding treatment, a very thin aluminum nitride single crystal film having a thickness not longer than 100 Å on the sapphire single crystal substrate surface, and the above mentioned buffer layer is formed on this film.” (Nakamura at paragraph **0021**).

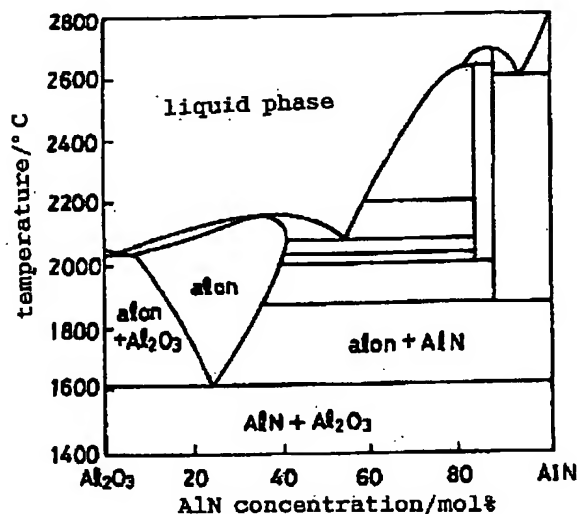
“During this initial nitriding treatment, on the surface of the sapphire single crystal substrate 1 is formed a very thin AlNO film having an average thickness of about several tens micron-meters. This thin film is not shown in Fig. 2.” (Nakamura at paragraph **0036**).

As described above, (i) a very thin AlN single crystal film is formed on the sapphire single crystal substrate surface by an initial nitriding treatment according to paragraph **0021** of Nakamura, and (ii) a very thin AlNO film is formed by the above treatment according to paragraph **0036** of Nakamura. However, these assertions of Nakamura fail to set forth a viable technology as is discussed below.



Since it is impossible to simultaneously form AlN and AlNO on the surface of the sapphire single crystal substrate, the above paragraphs in Nakamura mean that an AlN single crystal film is formed at one point in time and an AlNO film is formed at another time, according to the initial nitriding treatment conditions.

The AlNO of the AlNO film differs from the technical term "AlON (alon)" which is commonly used in the present invention or in this technical field. It is difficult to believe that the inventors of Nakamura, who are familiar with this technical field, wrote "AlNO" by mistake. As understood from the phase diagram depicted in Fig. 2 of the present invention (shown below), crystalline AlON (alon) cannot be existent stably at 950 °C, which is the initial nitriding treatment temperature in paragraph 0036 of Nakamura.



*Fig. 2 of the
present invention*

Additionally, Nakamura fails to disclose or suggest that the AlN single crystalline film is formed on the AlNO film.

Further, the thickness of the AlN single crystal film (i) is not larger than 100 Å (paragraph 0021 of Nakamura) whereas the thickness of the AlNO film (ii) is several tens of



microns (paragraph 0036 of Nakamura). The thickness of the AlNO film is thus about several thousands times larger than the thickness of the AlN single crystal film. This difference in thickness clearly cannot be made by the same initial nitriding treatment. Nakamura also fails to teach the method of actually measuring these thicknesses. Fig. 2 and Fig. 3 of Nakamura (shown below) show a buffer layer 2 having a thickness of 0.1 to 0.2 μm , and Fig. 3 shows an AlN single crystal layer 3 having a thickness of 2 to 3 μm formed by MOCVD.

FIG. 2

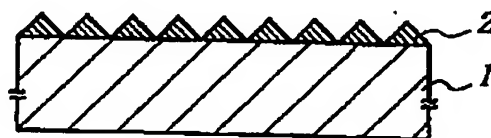
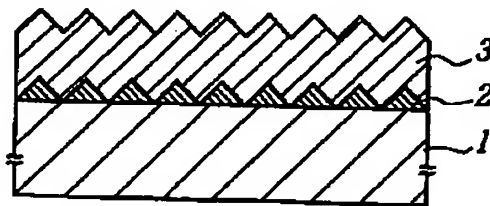


FIG. 3



*Figs. 2-3 of
Nakamura*

It is notable that the AlNO film, which is much thicker than these layers, is not shown in Fig. 2, even though it is discussed in paragraph 0036 of Nakamura. It is apparent from this disclosure that the formation of the AlNO film is not confirmed and may be a mere presumption.

The examiner also states that "AlON is necessarily single crystalline" in paragraph 8 of the Office Action. However, Nakamura would explicitly state that the film is crystalline when it is, since the inventors wrote "aluminum nitride single crystal layer" at, e.g., paragraphs 0032 and 0033 of Nakamura. The reason that the inventors wrote "AlNO film" in paragraph 0036 of

Nakamura arises from the formation of the film not being confirmed, and it is unknown whether AlNO is crystalline or not unlike AlON. As a result, the assertion "AlON necessarily is single crystalline" in the Response to Arguments (paragraph 8 of the Office Action) represents a misinterpretation of the technology of Nakamura.

As described above, Nakamura fails to disclose that the AlN single crystal film is formed on the AlNO film by the initial nitriding treatment. In addition, since Nakamura discloses a method in which a buffer layer is formed by MOCVD after the initial nitriding treatment and an AlN single crystal layer is formed on the buffer layer, Nakamura fails to disclose an AlN single crystal layer formed even on the AlON single crystal layer as the outermost layer.

Nakamura thus clearly fails to anticipate claim 1 of the present invention. Claims depending upon claim 1 are patentable for at least the above reasons.

At page 4, lines 12-14 of the Office Action, the Examiner unequivocally admits that Nakamura fails to teach that the substrate is nitrided by heating in the presence of carbon, nitrogen and carbon monoxide. The Examiner then turns to Bolt to reject claim 2 of the present invention.

Bolt at column 3, lines 55-60 discusses a preferred temperature range of 1550 to 1800 °C where one mole of alumina reacts with three moles of carbon and one mole of nitrogen to produce two moles of aluminum nitride and three moles of carbon monoxide.

In contrast, paragraph **0041** of the specification of the present invention discusses a weight ratio of carbon to single crystalline α -alumina of 0.1 to 1 (claim 4). Paragraph **0042** of the specification of the present invention discusses a mixing ratio of carbon monoxide to nitrogen of 0.1 to 0.5 (claim 5). That is, the carbon monoxide of Bolt is a waste product, but in

the present invention the carbon monoxide is a reactant. Bolt additionally fails to address the deficiencies of Nakamura in disclosing or suggesting claim 1 of the present invention.

However, at page 7 of the outstanding Office Action, the examiner states: "The combination of Nakamura and Bolt teaches forming a single crystalline AlN film."

Since Nakamura fails to teach that the AlN single crystal film is formed on the AlNO (or AlON) single crystal film by the initial nitriding treatment, as described above, the combination of Nakamura and Bolt fail to disclose or suggest that the single crystalline AlN film is formed by nitriding. Although Nakamura et al teach that the AlN single crystal layer is formed on the buffer layer by MOCVD, and MOCVD differs from nitriding of the present invention.

As a result, one of ordinary skill in the art would not be motivated by Nakamura and Bolt to produce claim 2 of the present invention. A *prima facie* case of obviousness has thus not been made.

These rejections are overcome and withdrawal thereof is respectfully requested.

Double Patenting Rejection

Claims 1-2 are provisionally rejected on the ground of obviousness-type double patenting over claim 3 of copending application No. 10/937,344. Applicants traverse, and respectfully request withdrawal of this rejection as being improper.

The instant application has 3 inventors: H. Fukuyama, K. Nakata, and W. Nakao. In contrast, copending application No. 10/937,344 has 5 inventors: H. Fukuyama, W. Nakao, S. Kusunoki, K. Takada and A. Hakomori. As a result, the instant application and copending application No. 10/937,344 have different inventorship.

The instant application is solely assigned to The Circle For The Promotion Of Science And Engineering, as is evidenced by the Assignment of parent application 10/247,539 (U.S. Patent 6,744,076) filed at reel 013602, frame 0117. In contrast, copending application No. 10/937,344 has a dual assignment to Tokuyama Corporation *and* The Circle For The Promotion Of Science And Engineering, as is evidenced by the Assignment filed at reel 015784, frame 0197.

As is set forth in MPEP 804.03(I), commonly owned applications of different inventive entities may be rejected on the grounds of double patenting.

However, MPEP 706.02(I)(2)(I) presents a definition of common ownership:

The term “commonly owned” is intended to mean that the subject matter which would otherwise be prior art to the claimed invention and the claimed invention are entirely or wholly owned by the same person(s) or organization(s)/business entity(ies) at the time the claimed invention was made. If the person(s) or organization(s) owned less than 100 percent of the subject matter which would otherwise be prior art to the claimed invention, or less than 100 percent of the claimed invention, then common ownership would not exist. Common ownership requires that the person(s) or organization(s)/business entity(ies) own 100 percent of the subject matter and 100 percent of the claimed invention.

As a result, the provisional double patenting rejection is improper due to the lack of common ownership between the present invention copending application No. 10/937,344. The Examiner is thus respectfully requested to withdraw this provisional double patenting rejection as failing to conform with the United States Patent and Trademark Office’s rules.

Information Disclosure Statement

The Examiner is thanked for considering the Information Disclosure Statement filed March 26, 2004 and for making the initialed PTO-1449 form of record in the application in the Office Action mailed May 3, 2005.

The Drawings

The Examiner is respectfully requested to indicate whether the drawing figures are acceptable in the next official action.

Foreign Priority

The Examiner has acknowledged foreign priority in the Office Action mailed May 3, 2005.

Conclusion

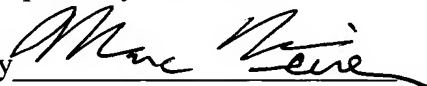
The Examiner's rejections have been overcome, obviated or rendered moot. It is believed that a full and complete response to the Office Action has been made. No issues remain. The Examiner is accordingly respectfully requested to place the application in condition for allowance and to issue a Notice of Allowability.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Robert E. Goozner, Reg. No. 42,593 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.14; particularly, extension of time fees.

Dated: **SEP 7 2006**

Respectfully submitted,

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